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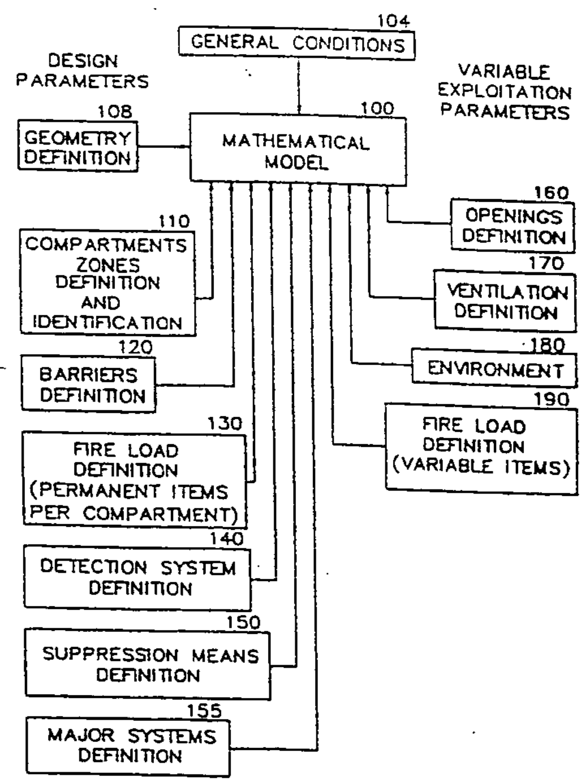
(54) Title: FIRE CRISIS MANAGEMENT EXPERT SYSTEM

(57) Abstract

An expert system for fire crisis management within a structure, including the prediction of fire propagation and explosion risks, with information of fire status, display signals for evacuation of occupants, ongoing fire damage, and on suppression means to be used. The system can be initiated manually or by a signal received from a detection or monitoring system. Degradation of the structure and installed systems from fire and explosion damage are calculated by a computer. The computer provides information on suppression means to use, and automated mechanical systems can be activated. The expert system is dynamic and adjusts its prediction and automated action as the crisis situation evolves. The expert system can also be used for structure design analysis and improvements, for intervention team training and for disaster history retrieval.



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FIRE CRISIS MANAGEMENT EXPERT SYSTEM

BACKGROUND OF THE INVENTION

Fire crisis management has been made so far by man as an on site intellectual decision process where only a limited amount of information could be efficiently analyzed. As structures became more larger and more complex, it soon became impossible to take into consideration all the pertinent factors affecting fire crisis management. A rational method based on scientific approaches was needed so to be able to analyze all relevant information.

To be efficient in crisis management, an expert system has to provide prediction on a time reference in a short period of time, or almost instantly. Large memory computers having high speed data processing capabilities only recently have made it possible to obtain such results. Furthermore, multi-tasks have to be processed in parallel, such as fire propagation prediction; data presentation; evacuation signals displays; suppression means activation and control. A multi-tasks exploitation system, and efficient computer programming, were also necessary.

The present expert system invention makes use of a computer procedure for the analysis of an enormous amount of information for the prediction of fire propagation, for the selection of appropriate means, for the diagnosis of relevant actions, to activate mechanical systems for fire suppression in a follow-up manner.

The expert system applies to all structures, such as ships, offshore platforms, refineries, high risk industries, horizontal and vertical buildings, nuclear plants, aircraft and space vehicles.

Further, the expert system can be used by architects and engineers for structure design analysis and improvement purposes. Additionally, the expert system is also capable of providing a simulated fire crisis which can be used by intervention teams for training purposes in a

non-critical time frame. The expert system turns to a fire crisis management function when a fire is announced. Fire information may be entered manually, or preferably obtained from a detection or monitoring system.

A fire crisis management expert system becomes very useful, and even essential for preservation of life, as real time on site crisis analysis tasks are often beyond normal human capabilities. Occupied or crowded structures need rational fire crisis management to provide adequate instructions to the occupants for evacuation. Danger suppression means activation may interfere with human evacuation if not properly analyzed. The real time fire crisis management expert system seeks to provide an efficient answer to the above described situation.

The system can be used for fire crisis management in lieu of a fireman team for a fully automated installation; for less elaborate installation it can be used in support of a fire intervention team for decision making assistance at various levels.

The system can cope with multiple sensor signals, such as the Christmas tree syndrome not yet addressed elsewhere.

SUMMARY OF THE INVENTION

The present invention seeks to produce information, decisions and actions for structure fire crisis management providing fire status; evacuation of occupants; evacuation of smoke, heat, and fumes; and also on fire or explosion risk suppression means. The expert system can be initiated manually or can be initiated by fire detection or monitoring devices. It predicts on a time reference the fire propagation, most likely paths and associated explosion risks, degradation or destruction of the structure and of systems installed therein. The evacuation of people is directed through analysis of the appropriate escape route(s) and, if desired, automatic operation of light signals installed within the structure in strategic locations. The signals are adjusted as the

fire crisis situation evolves. Thus, the expert system develops a complete fire intervention plan, and provides information to a user indicating the status of the fire crisis within the structure.

Within the fire intervention plan, adequate fire or explosion suppression means are selected amongst those available and information on their use is provided for manual, semi-automated or fully-automated functioning, as a further part of the fire intervention plan.

The expert system compares its prediction with signals received from the detection device(s) and consequently adjusts itself.

The degradation of passive and active systems within the structure resulting from fire or explosion is anticipated and taken into account in the evaluation of survivability of said systems, and their subsequent efficiency for further use in managing the fire crisis. The decision making process is based on a diagnosis process constantly updated with regularly renewed data produced by the fire propagation and explosion risk assessment modules. Their predictions are regularly compared to all available sensors device data.

The system is integrated as the structure mathematical model made can be used in subsequent phases for design purposes by architects and engineers, for intervention team training prior to operation or delivery of the structure and in current operation by launching disaster simulations. Finally, in the last phase of development of the model, it can be used as such in the expert system. Coarse modelling is permitted at an early stage of project definition and can be refined as the project evolves.

The system is designed to read multiple types of communication protocols from existing detection systems.

The invention includes as an option a simple analogic binary communication protocol for sensors

recognition; this can be verified several times per second for validity.

The invention also permits retrofit installation on an existing structure, without replacement of existing detection system and cables, or as part of an upgrading of an existing fire detection and control system.

Thus, in a first broad embodiment, this invention seeks to provide an apparatus for fire crisis management, or for simulating a fire crisis, within a structure, including in combination:

(i) a computer device containing a mathematical model defining the structure;

(ii) a plurality of sensor devices located within the structure, constructed and arranged to provide data to the computer device, which data is indicative of the status of a fire crisis at at least one locus in the structure;

(iii) a first program element contained in the computer providing potential fire damage and propagation in the structure based on the data provided by the sensor devices;

(iv) a second program element contained in the computer adapted to determine the integrity and validity of the data provided by the sensor devices; and

(v) a third program element contained in the computer adapted to predict a fire intervention plan, and to provide to at least one user, through a user interface, quantitative information indicating the status of the fire crisis within the structure.

Preferably, the apparatus includes means to provide signals to activate automatic fire intervention devices, such as fire and explosion suppression means; electrically and mechanically operated fire containment means; fire alarm means; and occupant evacuation route indicator means.

Preferably, the apparatus additionally includes a substantially fire resistant memory means, capable of showing at least some of the data generated and processed during a fire crisis management, and which can be retrieved intact after a fire crisis has been extinguished.

Preferably, the apparatus also includes a fifth program element contained in the computer device adapted to provide a simulation of a fire crisis within the structure, and to provide to the first, the second, and the third program elements data to predict a fire intervention plan for the simulated fire crisis.

In a second broad embodiment, this invention seeks to provide a method for the management of a fire crisis within a structure, which comprises:

(a) recording in a computer device a mathematical model defining the structure;

(b) obtaining from at least one sensor device within the structure data indicative of a fire crisis;

(c) comparing the data by means of a first computer program element contained in the computer device with the mathematical model and thereby deriving potential fire damage and fire propagation information;

(d) verifying the integrity of the data provided by the sensor devices by means of a second program element contained in the computer device; and

(e) by means of a third program element contained in the computer device predicting a fire intervention plan, and providing to at least one user interface quantitative information indicating the status of the fire crisis within the structure.

Preferably, the method includes the step of receiving continuously the data provided by the at least one sensor device, and, by means of a fourth program element contained within the computer, updating the first and third program elements in response to changes in the fire crisis within the structure.

Preferably, the method also includes the further steps of simulating a fire crisis within the structure by means of a fifth program element contained within the computer; providing to the first, second, and third program elements data indicative of a simulated fire crises within the structure; and predicting a simulated fire intervention plan in accordance with the simulated fire crisis, and providing to the at least one user interface quantitative information indicating the state of the simulated fire crisis within the structure.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: is a flow chart summary of the fire explosion crisis management expert system.

Figure 2: is a description of components and systems incorporated in the structure mathematical model.

Figure 3: is a schematic diagram of the fire propagation and explosion evaluation procedure module.

Figure 4: is a detailed schematic diagram illustrating correspondence between modules and logical sequences.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

One embodiment of the invention will now be described by way of reference to the drawings. This embodiment was developed primarily for use in a ship, but it is not so limited. It can be used for any relatively large structure, as is indicated above. In all applications, a key factor is the mathematical model of the structure, which is developed with direct reference to the particular structure within which the expert system is to be used. This will include definitions of available fire containment and suppression means; of available sensor devices and their several locations; of possible evacuation routes for occupants; and any other particular factor pertinent to the particular structure.

1. **HARDWARE**

The system works from a computer including the specially written programs. The computer can be either a permanent installation, portable or laptop type unit to suit operational requirements as shown in Figure 1.

The computer includes a mathematical model of the structure definition either on hard disk or embedded in a permanent memory (100). Fire or explosion occurrence can be derived from sensor devices and/or monitoring devices, or declared by the user in a signal recognition unit (200). Thus, this will include a manually operated fire alarm system.

The fire propagation and explosion assessments are calculated by the computer (300) using the first program element so to define the structure damage (400) and system damage (500) based on the mathematical model (100).

The computer executes a second program element, which is an analytical process covering basic logical rules for the integrity and the validity of fire crisis generated data (600).

The computer also executes a third program element, which is a diagnosis process providing prediction of damage (700) to the structure and its integrated systems

including a comparison with the recent sensor device signals received in (200). It verifies if the sensor location signal (200) corresponds to 100, and questions surrounding neighbours, as obtained in 100. It provides the expert system decision making process, and erects a fire intervention plan with quantified information for graphical understanding of the fire crisis status, which can be displayed through monitors (1000) for the benefit of occupants, including structure administration personnel and fire crises management team members (1100). The computer also provides signals and automated functions for evacuation of occupants (900) with color codes for valid, threatened, and impaired routes of evacuation, respectively in green, yellow, and red. Other suitable alternative identifying indication can be used in a monochrome monitor (1000). Light signals, which are located in corridors, doors, stairways, elevators, and other rooms and spaces, together with other electrical and mechanical automated devices can be activated through this module as described below. Means of fire and explosion suppression through electrical and mechanical devices (800) also can be activated, as described below. The computer system can also accept continuous incoming sensor device signals, as it updates itself constantly.

2. **MATHEMATICAL MODEL**

The manner in which the structure is defined as a mathematical model is shown schematically in Figure 2. In creating the mathematical model (100), a number of factors concerning the structure are utilized.

The geometry of the structure (108) is determined, and internal compartments are defined, together with a definition of compartment functions, and internal zones.

The internal barriers definition (120) will include data on the ability of a given barrier to resist both fire and explosion. Factors such as material of construction, internal air layers, supporting structures

arrangements and inbuilt safety factors, cable and service pipe penetrations, and ventilation system penetrations, are all included. A further important factor in this definition includes data on barrier destruction and blast effects as a result of an explosion.

The fire load definition for a given compartment has two components. The permanent component (130) represents the potentially combustible materials installed in the compartment. This will include assessment of combustible material type, weight and volume; material flash point; ignition temperature; and the nature of vapours produced on combustion. The variable component (190) represents potentially combustible materials temporarily present in a compartment. This will include fuel, oil, and other combustibles; dangerous freight, such as explosives; stores, such as paint and the like; and chemical products requiring special handling in a fire situation.

The detection system definition (140) includes data on the devices present to detect and to monitor a fire crisis. Thus, this definition includes data on available sensor devices, such as fire detectors, smoke detectors, vapour detectors, heat detectors, flame detectors, water detectors, and air pressure detectors, together with the control systems associated with these devices. This definition will also include data on the strategic location of system cables.

The suppression means definition (150) includes data on the services available to suppress fire or explosion. It thus includes data on available water supply, together with quantity and pressure on both a short and long term basis; inert gas systems; sprinklers; foam systems; manual use fire extinguishers and their locations; fire hoses; fire pumps, both to supply and to remove water, including moveable units and their location; piping systems; and electrical supply systems, including the location of access points, fuses, and the like.

The major systems definition (1155) assesses the systems installed within the structure in accordance with the principal use of the structure. This will include the location, function, and purposes of these systems; the nature of the components used in them. This will also include an assessment of installed systems survivability as a consequence of fire and explosion aggression.

In addition to these definitions for essentially fixed parts of the structure, in addition to the presence of inflammable materials, there are other variable parameters which need to be considered. These are mainly concerned with the use of the structure.

The openings definition (160) is concerned with the status of openings, such as doors, windows, portholes, hatchways, access panels, sacrifice panels, and the like.

The ventilation definition (170) is concerned with the status of the ventilation system; forced, natural circulation, funnels, chimneys, corridors, stair cases, air and lift shafts, structure voids, ducting, and internal pressure systems.

The environment definition (180) is concerned with factors such as the current use of the structure; external weather conditions, including wind direction, atmospheric pressure; visibility and structure orientation relative to the prevailing weather conditions; date and time of the cruise; status of the external electrical and water supplies; status of external communication systems, such as telephone and radio-telephonic links; and other external conditions which may affect how a fire crisis is managed. For a ship, for example, a material factor of no relevance to a land structure is sea condition.

Finally, although the initial geometry and compartments definitions can be readily determined based on the original construction of the structure, a general condition definition (104) is also used. This description takes into account factors such as the age of the structure; improvements and changes made during any refit;

geneneral maintenance policies, and the overall continuing integrity of the structure.

The invention also permits a mathematical model generated for structure design purposes to be transported into the expert system for training purposes or crisis management. The model can be started in a coarse format and refined or subdivided as the design or construction evolves, and especially in response to any design modifications. The invention permits to carry further any modelling work already performed on a specific structure, and avoids the duplication of work from the design phase into an exploitation mode for the structure. The model can be stored on a hard disk for prototypes or the initiation phase of a project such as used in a design phase, and on programmable chips for permanent expert system installation.

3. FIRE PROPAGATION AND EXPLOSION PREDICTION

The system includes a computer program (Figure 3) which defines fire propagation paths on the basis of a scientific evaluation of barrier degradation as a consequence of heat aggression. Once a fire recognition is announced (200), a fire growth is calculated (310) to find if there is established burning (312) and later full-room involvement of all items present in the combustion (320).

Severity of fire aggression is calculated, heat release and energy impact (330) are found and combustion continuity is verified for burnout of combustible materials (332), combustion rate (334), burning rate (336), self-extinction by lack of oxygen or heat (338) and from confinement (340).

Aggression on compartment barriers and their resistance is defined (342) in parallel with explosion risk assessments (350) and corresponding potential blast overpressure (352). A barrier failure mode (360), if any, is established from either durability (362), thermal (366) or pressure (364) failures.

Probabilities of fire occurrence (370) in room of origin of fire and adjacent compartments are calculated for each room in a sequential manner creating a path of propagation (380) through iteration (310) until a fire propagation and explosion assessment path is completed (300). The present invention makes it possible to modify in real time the number and location of rooms of origin and adjust the propagation paths as new incoming signals from sensors are generated as the fire crisis situation evolves. Consequently, it is possible to keep the propagation path updated based on both predicted and confirmed information.

4. INTEGRATED EXPERT SYSTEM

The integrated expert system includes computer driven automated hardware acting as a replacement of, or in addition to, a fire intervention team providing functions for crisis status monitoring, evacuation means and suppression means as seen in figure 4.

The original structure mathematical model (100) remains intact in conjunction with sensors and signal recognition (200) as long as a degradation message is not received from the sensor monitoring module (220) or from a prediction produced by the first program element in the analytical processor (600). In such event prewarning messages are issued (210).

Any fire or explosion signal detected or initiated implies an aggression definition check procedure and assessment (300).

Presence of an aggression generated structural damage prediction (400, 420, 430, 440) and an internal systems degradation is also evaluated (500). Both results are integrated in an analytical process to define a common fault tree procedure (600). The mathematical model (100) is then adjusted to incorporate the latest analytical findings for future reference.

The structure primary missions are evaluated and assessed (640). A diagnosis process is initiated (700) defining priorities, rules of conduct, means to apply to

the fire crisis in reference to the mission of the structure, and prevailing external environmental conditions.

An incompatibility verification procedure is executed (750) so to avoid inadequate action, such as, for example in using water in a compartment containing concentrated sulphuric acid. A fault tree analysis is performed in order to respect current structures primary mission (720). Once a preferred intervention plan is confirmed after adjustments between the diagnosis process, fault tree analysis, and incompatibility verification (700, 750, 720), a real time fire crisis intervention plan is activated (760) continually informing the mathematical model (100) of detected or anticipated changes and comparing any detection signal to predicted evolution and adjusting when necessary. The plan is sent to the user interface for understanding (1100) and to history recollection black box (1150) for later inquiry purposes if needed providing a time incremental basis for status report (1110), evacuation means (1120), suppression means (1140) and fault systems identification (1160).

Crisis status is compiled and updated (762) on the basis of the real time update (760). The relevant announcement module is activated (770) and in turn activates a warning system (772), showing compartments or zones to be evacuated (774) in a sequential manner, under urgent and suggested qualifications. This is conveyed to occupants by a graphical mode, and through light and/or sound signals in the structure depending on compartment and zones implied, and on the warning systems available within the structure. Smoke invaded compartments, as detected and predicted (776), are displayed in a graphical manner, also.

Air or gas overpressure detected or predicted (778) are displayed in a graphical manner, as also are the explosion risks (780), and structure stability threat by use of water (782).

A "lost control" prediction (784) indicates anticipated time to go for fire (786), explosion (788) and structure stability (790).

Evacuation means decided under the intervention plan are adjusted to a real time report (764). The signal control interface (830) creates conventional communication protocols to direct and control in a follow-up mode (900) the systems and apparatus needed for human evacuation, such as circulation and emergency lighting systems within the structure (910), indication of muster station safety criterion (920) and escape routes (930), both to identify and to classify as valid, threatened or impaired. Also provided is activation of the ventilation system per zone for evacuation of smokes, gas and heat with pertaining dampers actuators (940). A pressure water system to be activated if required (950) and water to be evacuated if needed by drying pumps (960) are also controlled by (900), so are the electrical supplies (980) for both main and emergency sources and zones isolation. (900) also controls ventilation supply machineries and actuators (990).

The suppression means selected (768) under the intervention plan is detailed and communication protocols created to be transmitted to the electrical and mechanical control systems (840) operating in a follow-up mode the following systems: ventilation dampers actuators in fire zone (850), automated door controls (860), water diffusion (870), water sprinklers (872), foam dispenser (874), deluge system for total flooding (876), inert gas diffusion (878), explosion risks suppression (880) and circulation light signals network for access route to fire heart (882).

The system is designed to read multiple types of communication protocols from existing detection systems. The invention permits retrofit installation in existing structures.

The invention permits prediction of degradation of the structure and selection of pertaining preventive

countermeasures through automated electrical and mechanical devices.

The preceding description of a preferred embodiment has focussed on how the system reacts and assists the management and fire fighting teams when an ongoing fire crisis is present. It is also well known that such teams are able to work better and more efficiently if they can be adequately trained. It is eminently feasible to include into this system a further program element which will simulate a fire crisis, and will feed to the remainder of the system the necessary signals to initiate a simulated event, and it's likely ongoing behaviour. This permits the training in real time and on site of pertinent personnel under realistic conditions, but ones which do not involve the actual presence of a fire crisis. During such a simulation, the expert system will develop a theoretical fire intervention plan, and provide to the users the same sort of visual and audio data as would happen during an ongoing fire. The system, when in the simulation mode, can also include programming which will respond to the actions taken to deal with the simulated crisis in much the same way as will happen during a fire crisis.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An apparatus for fire crisis management, or for simulating a fire crisis, within a structure, including in combination:

(i) a computer device containing a mathematical model defining the structure;

(ii) a plurality of sensor devices located within the structure, constructed and arranged to provide data to the computer device, which data is indicative of the status of a fire crisis at at least one locus in the structure;

(iii) a first program element contained in the computer providing potential fire damage and propagation in the structure based on the data provided by the sensor devices;

(iv) a second program element contained in the computer adapted to determine the integrity and validity of the data provided by the sensor devices; and

(v) a third program element contained in the computer adapted to predict a fire intervention plan, and to provide to at least one user through a user interface quantitative information indicating the status of the fire crisis within the structure.

2. An apparatus interfaced with the computer according to Claim 1 further including:

(vi) means to provide signals to activate at least one automated fire intervention

device in accordance with the fire intervention plan.

3. An apparatus according to Claim 2 wherein the fire intervention devices include automated fire and explosion suppression means; electrically and mechanically operated fire containment means; fire alarm means; and occupant evacuation route indicator means.

4. An apparatus according to Claim 1 further including:

(vii) a fourth program element contained in the computer adapted to receive continuously the data provided by the at least one sensor device and to update the first and third program elements in response to changes in the fire crisis within the structure.

5. An apparatus according to Claim 1 further including:

(viii) a substantially fire resistant memory means, capable of storing at least some of the data generated during a fire crisis management.

6. An apparatus according to Claim 5, wherein the memory means stores at least some of the data generated by the sensor devices.

7. An apparatus according to Claim 5, wherein the memory means stores at least some of the fire intervention plan.

8. An apparatus according to Claim 2 wherein the quantitative information indicating the status of the fire crisis within the structure includes indication of the

activation of the at least one automated fire intervention device.

9. An apparatus according to Claim 1 further including:

(ix) means interfaced with the computer to provide signals to activate at least one evacuation route indicator device in accordance with the fire intervention plan.

10. An apparatus according to Claim 1 wherein the at least one activated route indicator device is constructed and arranged to show whether a given evacuation route is valid, threatened, or impaired.

11. An apparatus according to Claim 1 wherein the first program element includes subelements directed toward separately assessing fire damage to the structure, and fire damage to systems incorporated within the structure.

12. An apparatus according to Claim 1 futher including:

(x) a fifth program element contained in the computer device adapted to provide a simulation of a fire crisis within the structure, and to provide to the first, the second, and the third program elements data to predict a fire intervention plan for the simulated fire crisis.

13. A method for the management of a fire crisis within a structure, which comprises:

(a) recording in a computer device a mathematical model defining the structure;

(b) obtaining from at least one sensor device within the structure data indicative of a fire crisis;

(c) comparing the data by means of a first computer program element contained in the computer device with the mathematical model and thereby deriving potential fire damage and fire propagation information;

(d) verifying the integrity of the data provided by the sensor devices by means of a second program element contained in the computer device; and

(e) by means of a third program element contained in the computer device predicting a fire intervention plan, and providing to at least one user interface quantitative information indicating the status of the fire crisis within the structure.

14. A method according to Claim 13 further including

(f) receiving continuously the data provided by the at least one sensor device, and, by means of a fourth program element contained within the computer, updating the first and third program elements in response to changes in the fire crisis within the structure.

15. A method according to Claim 13 further including:

(g) storing in a protected and readable memory means at least some of the data generated during a fire crisis management.

16. A method according to Claim 15 wherein the memory means stores at least some of the fire intervention plan.

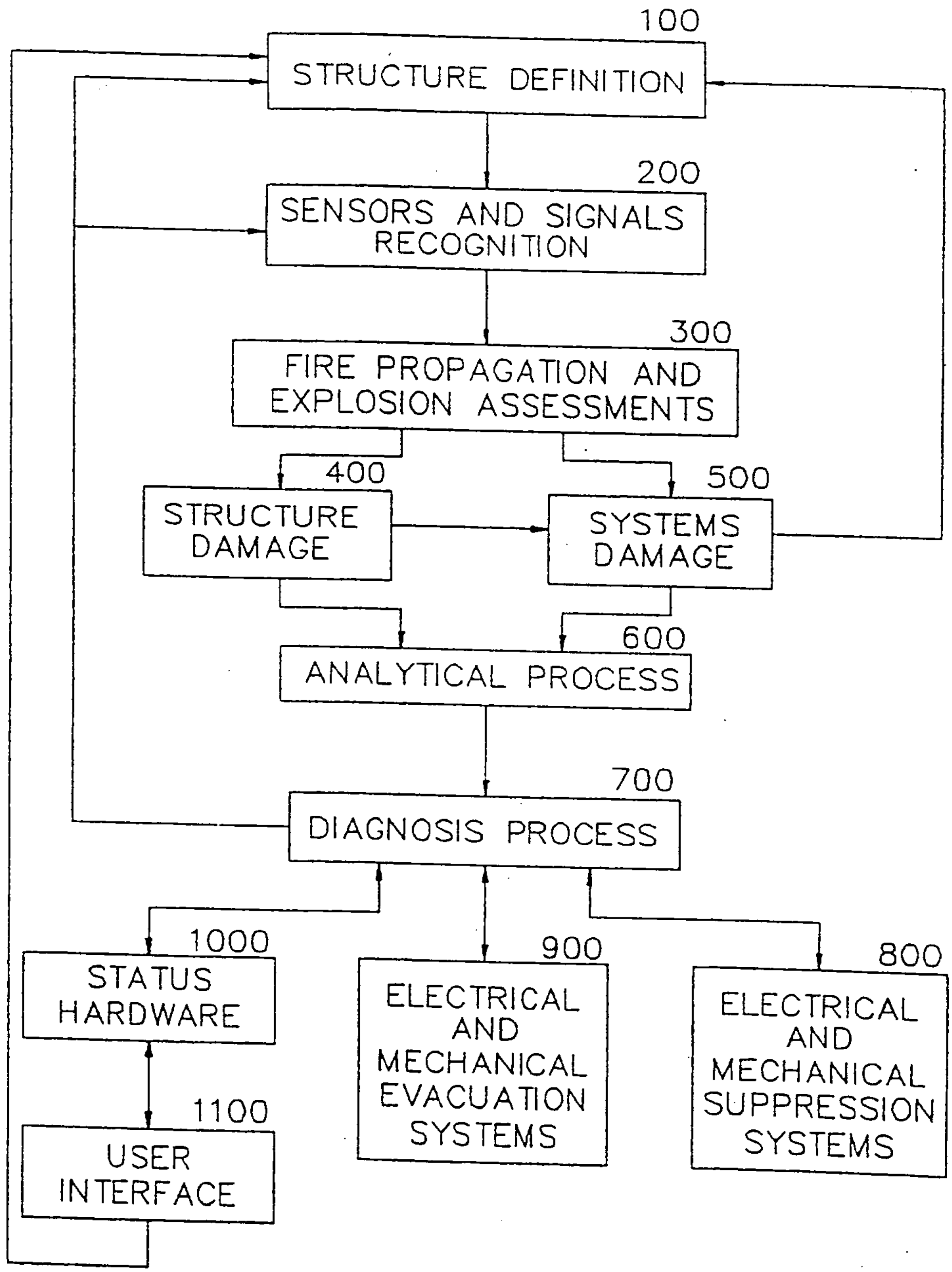
17. A method according to Claim 13 further including:

(h) simulating a fire crisis within the structure by means of a fifth program element contained within the computer;

(i) providing to the first, second, and third program elements data indicative of a simulated fire crisis within the structure; and

(j) predicting a simulated fire intervention plan in accordance with the simulated fire crisis, and providing to the at least one user interface quantitative information indicating the state of the simulated fire crisis within the structure.

FIG. 1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FIRE PROPAGATION AND EXPLOSION ASSESSMENTS
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STRUCTURE DAMAGE
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SYSTEMS DAMAGE
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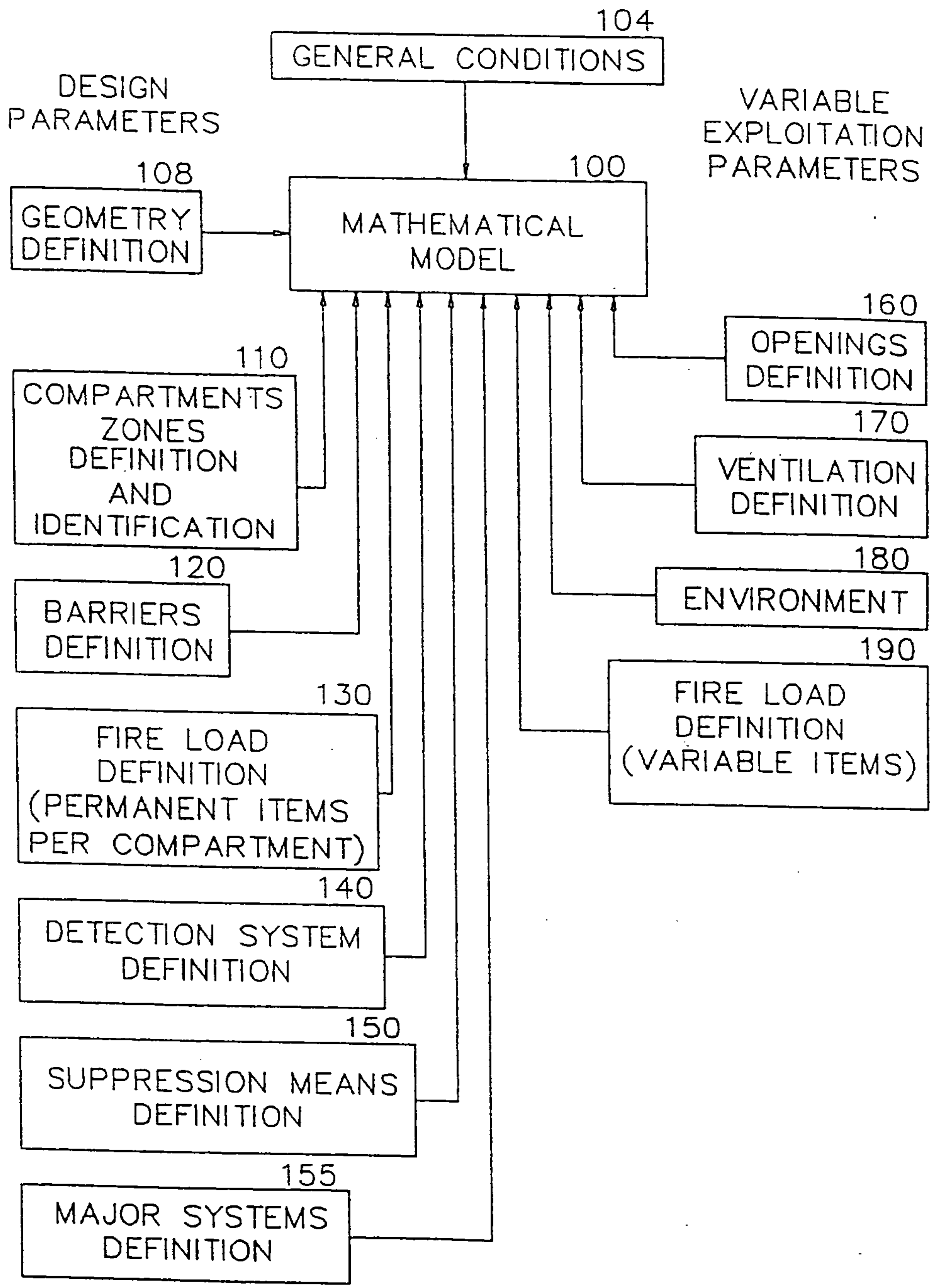
ANALYTICAL PROCESS
700
DIAGNOSIS PROCESS
1000
STATUS HARDWARE
900
ELECTRICAL AND MECHANICAL EVACUATION SYSTEMS
800
ELECTRICAL AND MECHANICAL SUPPRESSION SYSTEMS
1100
USER INTERFACE

FIG. 2


104
GENERAL CONDITIONS
DESIGN PARAMETERS
VARIABLE EXPLOITATION PARAMETERS
108
GEOMETRY DEFINITION
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MATHEMATICAL MODEL
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OPENINGS DEFINITION
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COMPARTMENTS ZONES DEFINITION AND IDENTIFICATION
170
VENTILATION DEFINITION
180
ENVIRONMENT
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BARRIERS DEFINITION
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FIRE LOAD DEFINITION (VARIABLE ITEMS)
130
FIRE LOAD DEFINITION (PERMANENT ITEMS PER COMPARTMENT)
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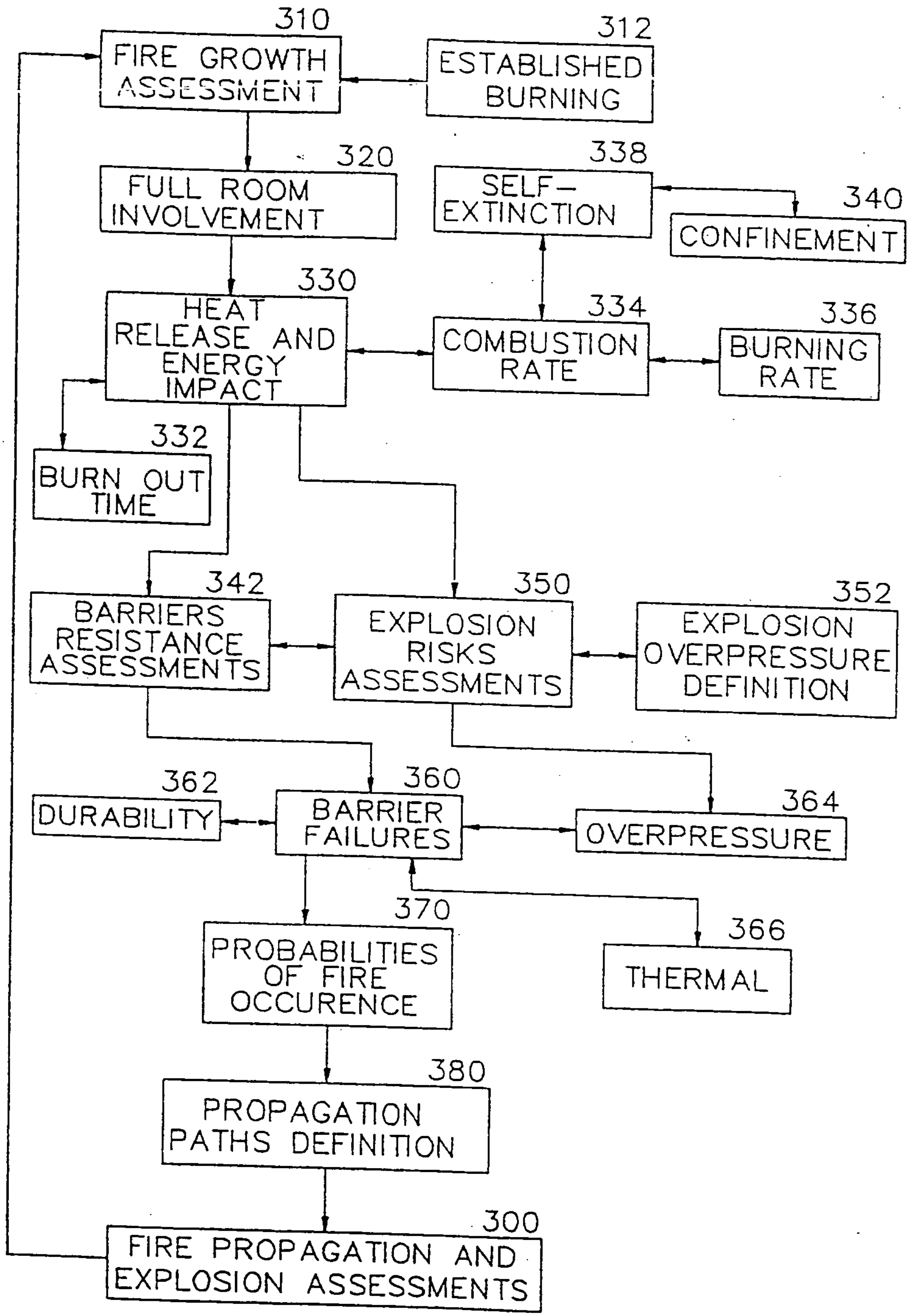
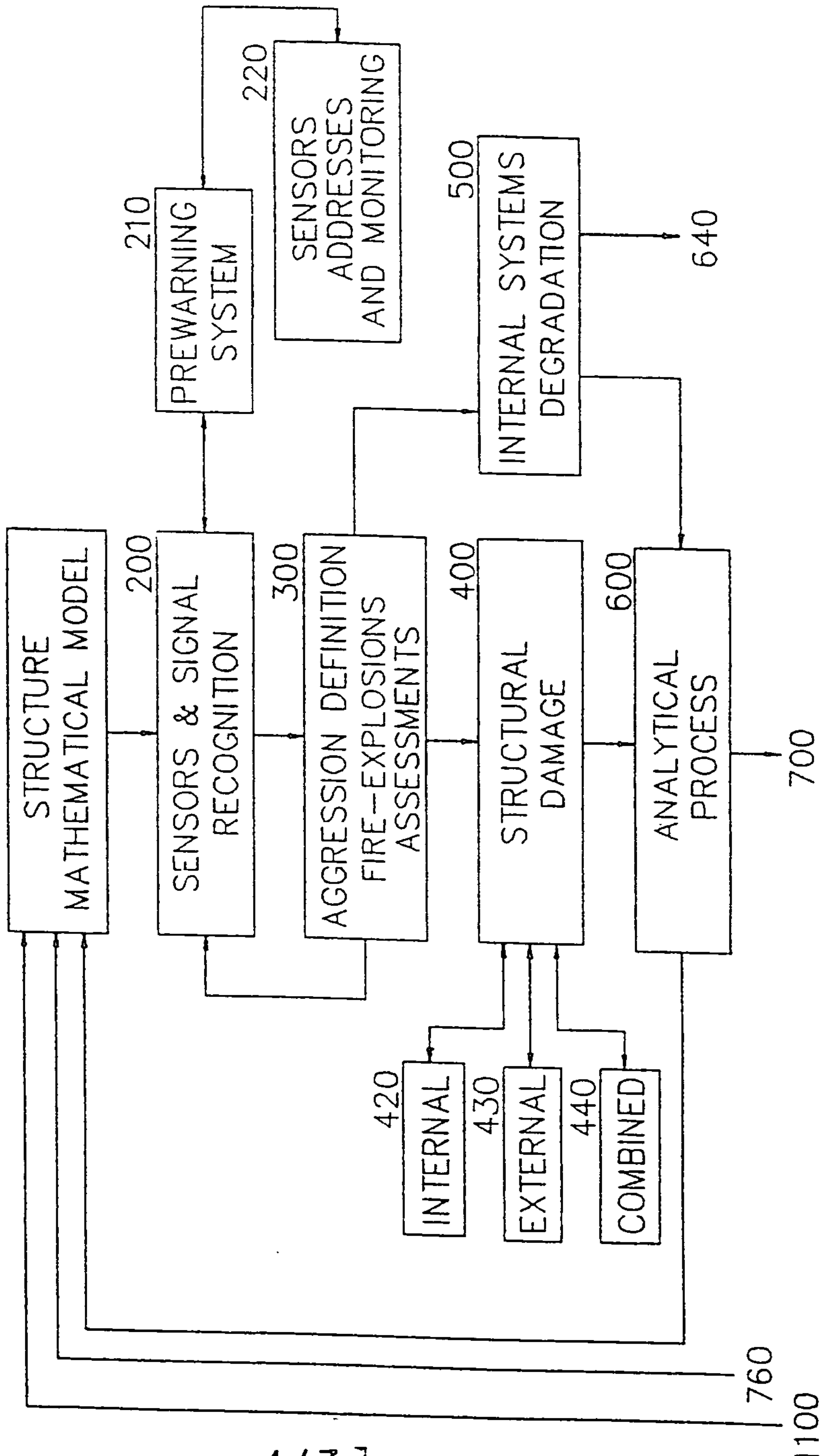
DETECTION SYSTEM DEFINITION
150
SUPPRESSION MEANS DEFINITION
155
MAJOR SYSTEMS DEFINITION

FIG. 3



SUBSTITUTE SHEET

FIG. 4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SENSORS & SIGNAL RECOGNITION
200
PREWARNING SYSTEM
210
SENSORS ADDRESSES AND MONITORING
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AGGRESSION DEFINITION FIRE—EXPLOSIONS ASSESSMENTS
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STRUCTURAL DAMAGE
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INTERNAL SYSTEMS DEGRADATION
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ANALYTICAL PROCESS
600
640
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760
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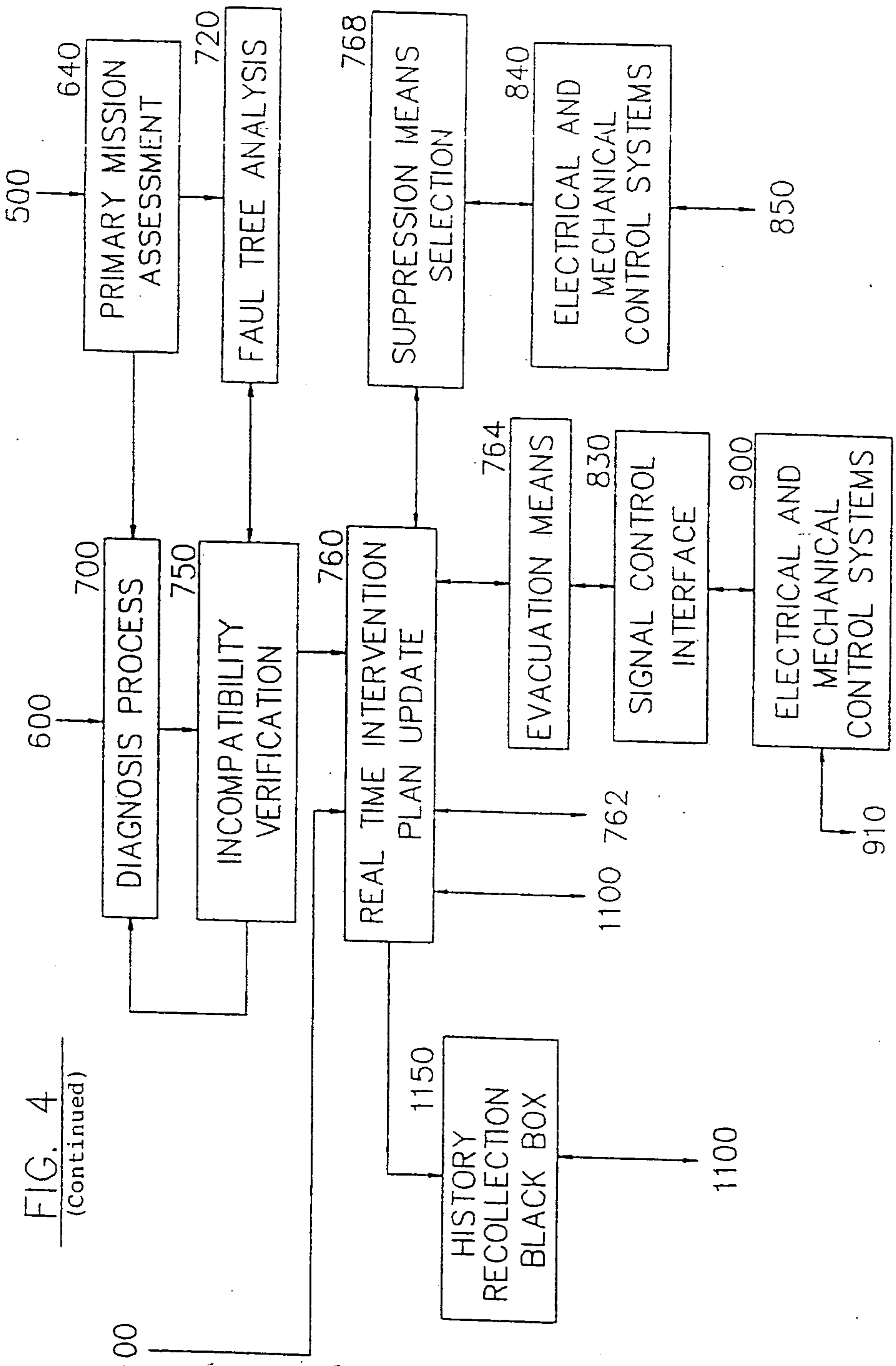


FIG. 4 (Continued)

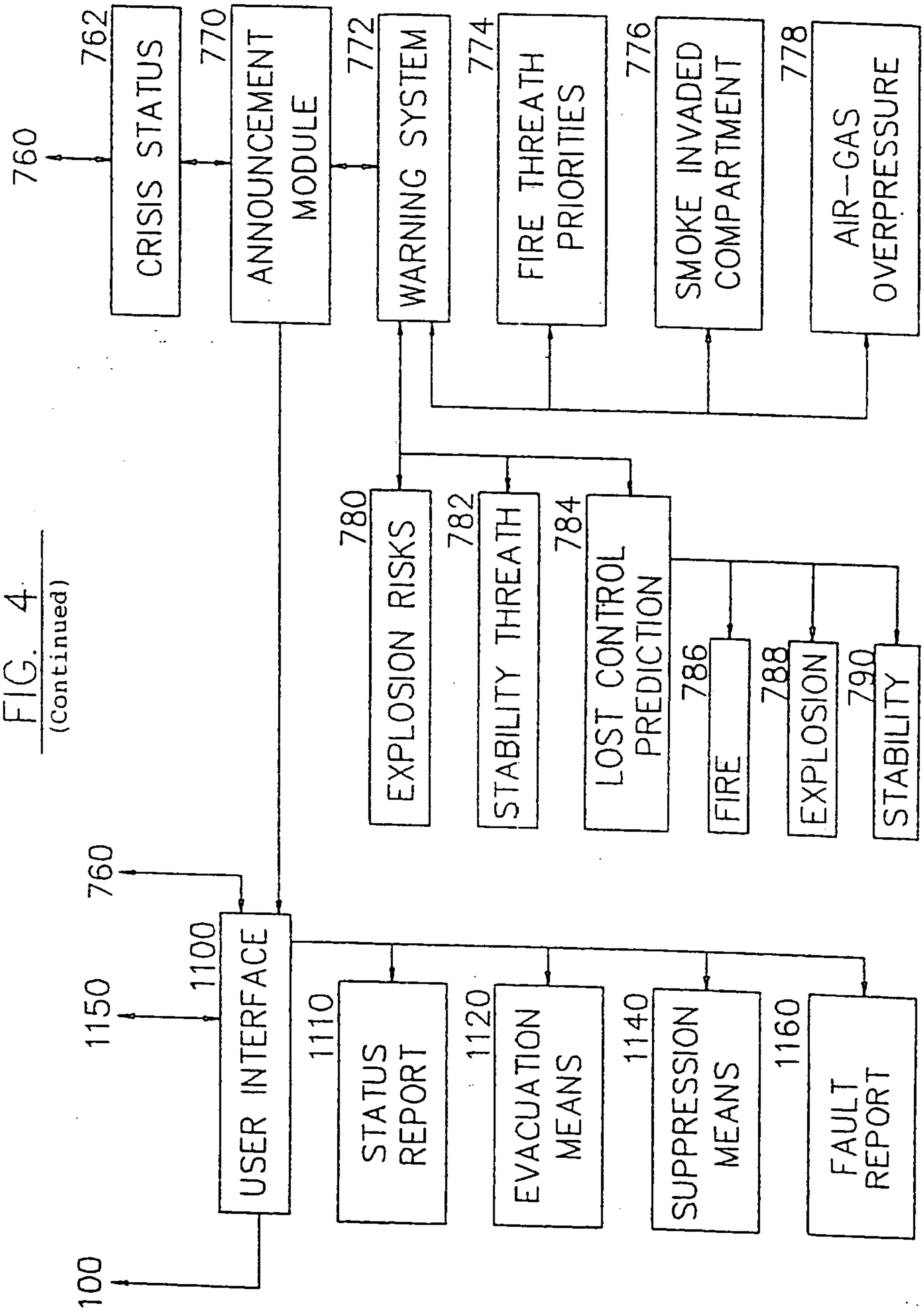
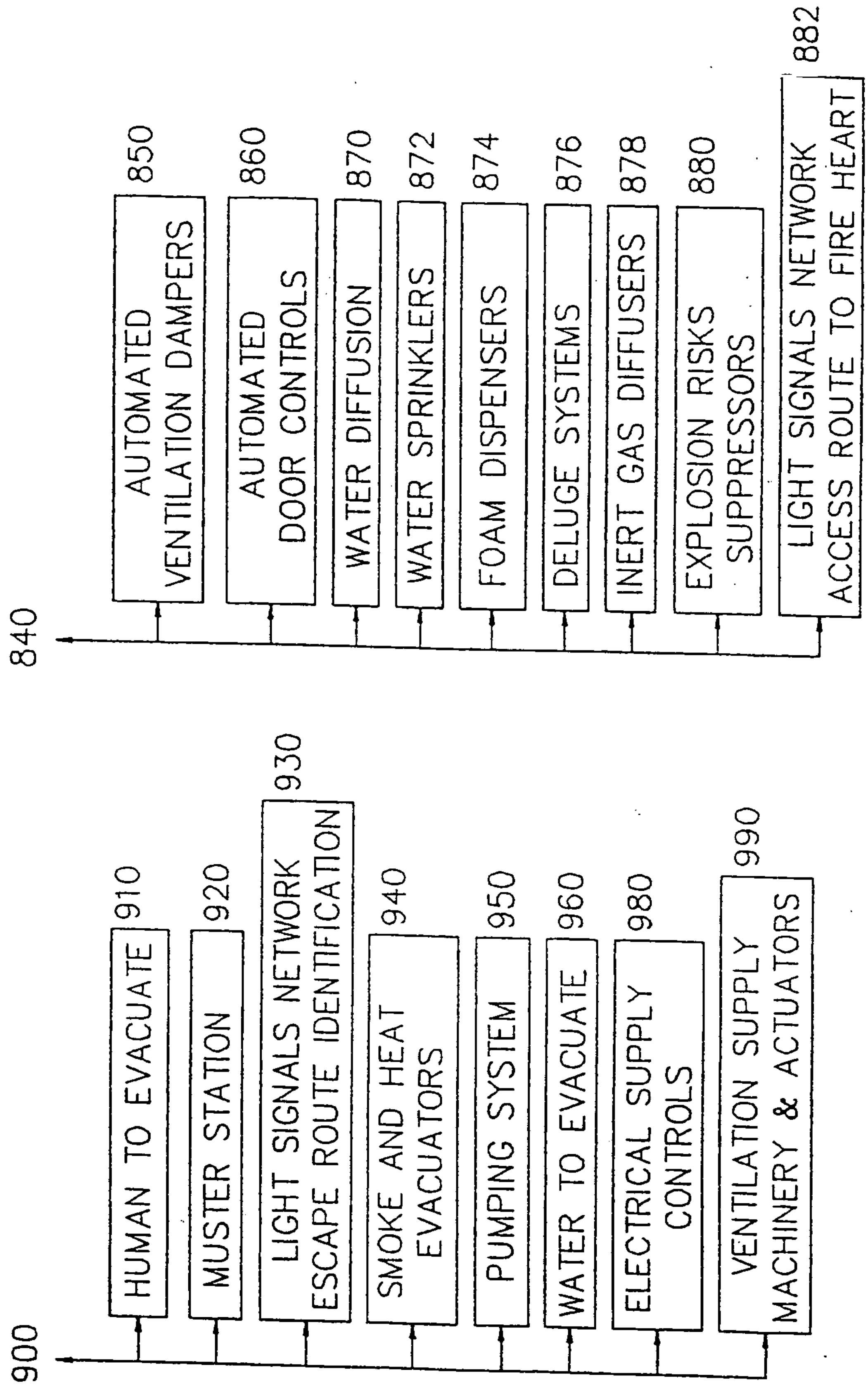


FIG. 4
(Continued)

FIG. 4
(Continued)



SUBSTIT

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 93/00114

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G08B25/14; G08B25/01; G08B17/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G08B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	WO,A,8 907 304 (MESSERSCHMITT-BÖLKOW-BLOHM GMBH) 10 August 1989 see claims see page 10, line 7 - page 11, line 5; figure 5 see page 12; figure 2 ---	1-17
Y	SOVIET PHYSICS -DOKLADY vol. 28, no. 4, April 1983, NEW YORK (USA) pages 328 - 330 GRISHIN ET AL. 'MATHEMATICAL MODELING OF THE SPREADING OF HIGH-LEVEL FOREST FIRES' ---	1-17
Y	GB,A,2 191 028 (HOCHIKI KABUSHIKI KAISHA (JAPAN)) 2 December 1987 see abstract --- -/--	3,9,10

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

1

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
29 JULY 1993	1.6.08.93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	REEKMANS M.V.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

CA 9300114
SA 72860

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 29/07/93

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82